

Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase II

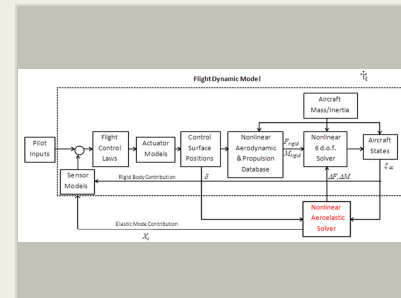
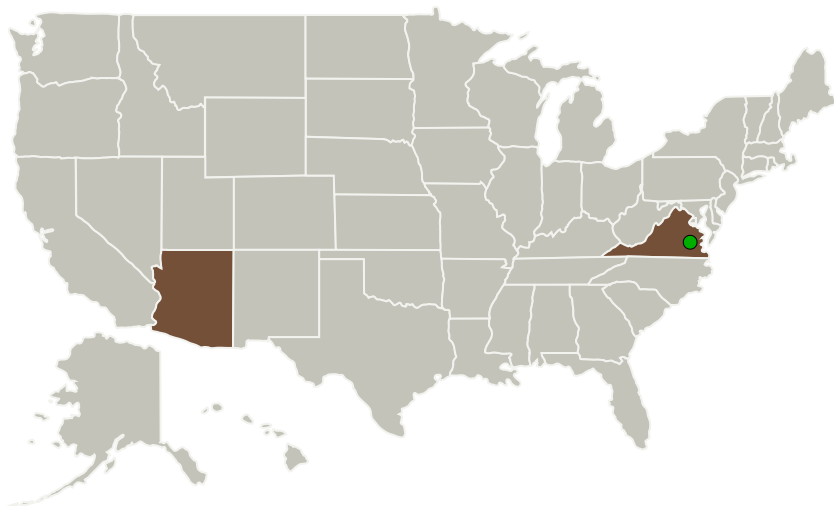
Completed Technology Project (2017 - 2019)



Project Introduction

The Nonlinear Dynamic Flight Simulation (NL-DFS) system will be developed in the Phase II project by combining the classical nonlinear rigid-body flight dynamics model with an add-on nonlinear aeroelastic solver to compute the airframe response due to pilot input command and to identify the key aeroelastic coupling mechanisms between the structural dynamics and unsteady aerodynamics with classic rigid-body dynamics. The nonlinear aeroelastic solver solves the aeroelastic equation of motion to add the incremental aeroelastic forces to the right hand side of the 6 degree-of-freedom equation in the flight dynamic model to account for the dynamic aeroelastic effects in the flight dynamic simulation. The generalized aerodynamic forces involved in the nonlinear aeroelastic solvers are provided by three nonlinear aerodynamic Reduced Order Models (ROMs); namely the modal, gust and control surface ROMs, that are derived from the Navier-Stokes (N-S) solver of FUN3D. The nonlinear modal ROM is constructed by a neural network model and the nonlinear gust and control surface ROMs are in the form of the first and second order Volterra Kernels. A wrapper around FUN3D, called OVERFUN, will be enhanced to drive FUN3D for generating the training data that leads to the three ROMs. OVERFUN also can directly drive FUN3D to perform a full order aeroelastic analysis including trim, flutter, gust and maneuver loads analyses whose solutions can be used to verify the accuracy of these three ROMs. The NL-DFS system will be validated with the flight test data of F/A-18 Active Aeroelastic Wing.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
ZONA Technology, Inc.	Lead Organization	Industry Small Disadvantaged Business (SDB)	Scottsdale, Arizona
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations

Arizona	Virginia
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Project Transitions

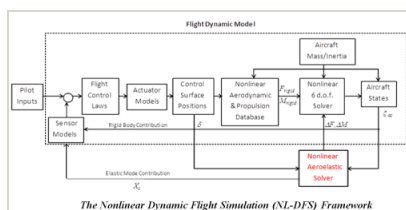
▶ **April 2017:** Project Start

✓ **April 2019:** Closed out

Closeout Documentation:

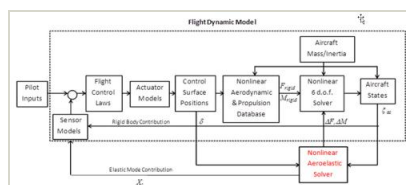
- Final Summary Chart(<https://techport.nasa.gov/file/141036>)

Images



Briefing Chart Image

Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase II Briefing Chart Image (<https://techport.nasa.gov/image/130713>)



Final Summary Chart Image

Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase II (<https://techport.nasa.gov/image/132253>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

ZONA Technology, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

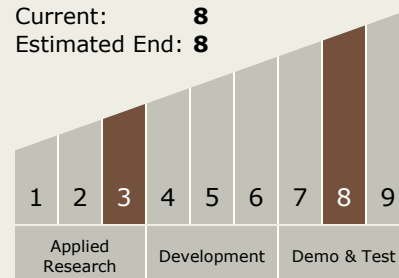
Carlos Torrez

Principal Investigator:

Zhicun Wang

Technology Maturity (TRL)

Start: 3
Current: 8
Estimated End: 8



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Technology Areas

Primary:

- TX15 Flight Vehicle Systems
 - └ TX15.2 Flight Mechanics
 - └ TX15.2.4 Modeling and Simulation for Flight

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System